REMARKS/ARGUMENTS

Favorable reconsideration of this application, as presently amended and in light of the following discussion, is respectfully requested.

Claims 1-5, 9, 11, 12, and 15 are pending in the present application, Claims 1, 3, 5, 9, 11, and 15 having been amended, and Claims 6, 10, 13, and 14 having been canceled with out prejudice or disclaimer. Support for the amendments to Claims 1 and 9 is found, for example, in the original claims. Support for the amendments to Claims 3 and 12 is found, for example, in Fig. 4. Accordingly, Applicants respectfully submit that no new matter is added.

In the outstanding Office Action, Claims 5, 8, and 15 were rejected under 35 U.S.C. §112, first paragraph; Claims 5, 8, and 15 were rejected under 35 U.S.C. §112, second paragraph; Claims 1, 2, 4, 5, 9-11, and 15 were rejected under 35 U.S.C. §102(b) as anticipated by, or in the alternative, under 35 U.S.C. §103(a) as unpatentable over Nakajima et al. (U.S. Patent Publication No. 2002/0139416, hereinafter Nakajima); and Claims 3, 6-8, and 12-14 were rejected under 35 U.S.C. §103(a) as unpatentable over Nakajima.

With respect to the rejection of 5, 8, and 15 under 35 U.S.C. §112, first and second paragraphs, Claims 5 and 15 are amended as suggested by the outstanding Office Action. Applicants respectfully submit that the rejection of Claim 8 under 35 U.S.C. §112, first and second paragraphs, is moot in light of the cancellation of Claim 8.

Accordingly, Applicants respectfully submit that the rejections under 35 U.S.C. §112, first and second paragraphs, is overcome.

With respect to the rejection of Claim 3, the subject matter of which is incorporated into Claim 1, as unpatentable over Nakajima, Applicants respectfully traverse the rejection.

In support of this traversal, Applicants respectfully submit the attached declaration under 37 CFR §1.132 to establish criticality of the claimed range by providing evidence of unexpected advantages.

MPEP §2144.05(III) states "Applicants can rebut a *prima facie* case of obviousness based on overlapping ranges by showing the criticality of the claimed range. 'The law is replete with cases in which the difference between the claimed invention and the prior art is some range or other variable within the claims.... In such a situation, the applicant must show that the particular range is critical, generally by showing that the claimed range achieves unexpected results relative to the prior art range. *In re Woodruff*, 919 F.2d 1575, 16 USPQ2d 1934 (Fed. Cir. 1990)."

Furthermore, Applicants respectfully submit that the submission of the attached declaration is timely under MPEP §716.01(3). The attached declaration is filed after a final rejection but before a filing a notice of appeal. The attached declaration is being submitted now because the outstanding Office Action is the first time the Office's position of "[n]othing unexpected has been demonstrated with respect to the selection of Nakajima et al's parameter M"[1] has been stated on the record. The attached declaration is filed to traverse this position.

The attached rule 1.132 declaration shows that there are unexpected advantages realized when selecting X to satisfy the relationship $X \leq 0.1$.

Nakajima discloses that wavelength dependency of short-circuit current to a light source having a spectral distribution of solar light was measured for each of a solar cell that uses microscopically uneven $Si_{0.5}Ge_{0.5}$ (i.e., $M = 0.5$) crystal and a solar cell that uses

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[1] See the bottom of page 12 of the Office Action mailed February 7, 2006.

microscopically even $Si_{0.5}Ge_{0.5}$ to crystal.[2] Fig. 3 of Nakajima shows the results of this comparison. Although Nakajima makes a broad sweeping disclosure that M takes a predetermined value greater than zero but less than one, there is nothing in Nakajima that suggests that the sub-range of less than or equal to 0.1 is better than other portions of the disclosed range.

Fig. 3 shows that for a solar battery, that uses a microscopically uneven $Si_{0.5}Ge_{0.5}$ crystal, has a larger total area as compared to the solar battery that uses microscopically even $Si_{0.5}Ge_{0.5}$ crystal. Consequently, the entire current value is higher, which results in a higher short-circuit current. [3]

However, Nakajima does not disclose or suggest that the short circuit current, open circuit current, and conversion efficiency of the a solar cell can be made significantly higher by setting the ratio of Ge to 10 atomic percent or less. There is no evidence in Nakajima that the ratio of Ge was ever set to 10 atomic percent or less.

As explained in the attached declaration, an experiment was conducted that compared the crystal of $Si_{0.5}Ge_{0.5}$ to a crystal of $Si_{1-x}Ge_x$, with $X \leq 0.1$ as described in amended Claim 1. As described in the attached declaration, when the $Si_{0.5}Ge_{0.5}$ was used in a solar cell, the open circuit voltage of the solar cell was 0.41V. This is significantly lower than the open circuit voltage of a solar cell that uses an Si polycrystal, which is about 0.55 to 0.58V.

Fig. 4B of the present application shows the open circuit voltage for a crystal of $Si_{1-x}Ge_x$, with $X \leq 0.1$ as described in amended Claim 1. As shown in Fig. 4, the open circuit voltage of the SiGe polycrystal of the claimed invention in which the Ge amount is set more

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[2] Nakajima, paragraph [0033].
[3] Nakajima, paragraph [0035].

than 0 atomic percent but no more than 10 atomic percent is about 0.43 to 0.58V. The open

circuit voltage of the SiGe polycrystal in which the Ge amount is set more than 0 atomic

percent but no more than 5 atomic percent is about 0.55 to 0.58V.

Contrary to the $Si_{0.5}Ge_{0.5}$ crystal, with the crystal of the claimed invention, a lowering

of the open circuit voltage, compared to the Si polycrystal, is not observed. Thus, a crystal in

accordance with the claimed invention exhibits unexpected advantages.

Experiment 2 in the attached declaration indicates that, for a non-limiting embodiment

of the invention of Claim 1, $Si_{0.97}Ge_{0.03}$ (in which segregation regions are dispersed within the

matrix) has significantly improved short circuit photocurrent, open circuit voltage, and

conversion efficiency as compared to microscopically even $Si_{0.97}Ge_{0.03}$. Such a technical fact

is not disclosed or suggested by Nakajima.

As also discussed in the present specification, the results of the experiments described

in the attached declaration are contrary to what a person of ordinary skill in the art would

expect. Figs. 4A-4D of the present application are graphs that show the dependency of solar-

cell characteristics upon Ge content with respect to the solar cell of the present invention,

compared to conventional ones. As is apparent from Figs. 4A-4D, the SiGe polycrystals of

the conventional art (i.e., M. Isomura et al. (2000) and P. Geiger et al. (2000)) contain GE in

an amount of 10 atomic percent or more. This is because those skilled in the art believed that

a desired conversion efficiency of a solar cell cannot be improved unless Ge is contained in a

large amount.[4]

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[4] Specification, page 13, line 24 to page 14, line 3.

Despite the technical common knowledge of the researchers at the time when the present application was filed, a crystal with the ratio of Ge set to 10 atomic percent or less can exhibit unexpected characteristics as a solar cell. Particularly, see Fig. 4B of the present application for the remarkable and unexpected external quantum efficiency and see Fig. 4C of the present application for the remarkable and unexpected open circuit voltage.

Furthermore, the inventors of the present application are not aware of any case where the characteristics of a solar cell which uses an SiGe crystal with the amount of Ge (X) in the range of $0 < X \leq 0.1$ were measured in a test prior to the filing of the present application. As discussed above and recited in the specification, researchers at the time of filing this application did not consider that it would be possible to achieve significant characteristics with a SiGe crystal as a solar cell with the amount of Ge (X) in the range of $0 < X \leq 0.1$.

Thus, the attached declaration supports the Applicants position that the claimed invention exhibits unexpected results. Furthermore, "A greater than expected result is an evidentiary factor pertinent to the legal conclusion of obviousness...of the claims at issue."[5]

In view of the above-noted discussion and attached declaration, Applicants respectfully submit that the *prima facie* case of obviousness set forth in the outstanding Office Action has been traversed.

Accordingly, Applicants respectfully submit that Claim 1 (and Claims 2, 3, 4, and 5 dependent thereon) patentably distinguishes over Nakajima.

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[5] MPEP §716.02(a).

Furthermore, Claim 3 is amended to recite "wherein said X satisfies the relationship: $X \leq 0.05$." Applicants respectfully submit that <u>Nakajima</u> does not disclose or suggest the subject matter Claim 3 for at least the reasons stated for Claim 1.
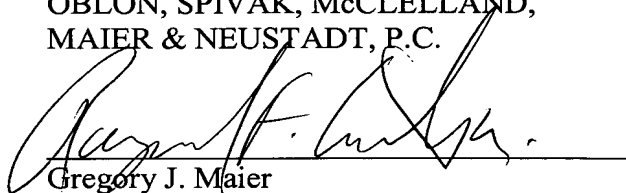
Claim 9 recites, *inter alia*, "each of the polycrystal grains manufactured has a crystallographic texture in which a plurality of discrete regions having an average composition represented by $A_{1-x2}B_{x2}$ are dispersed in a matrix thereof having an average composition represented by $A_{1-x}B_x$ where $X1 < X < X2$, and X satisfies the relationship $X \leq 0.1$."

Applicants respectfully submit that Claim 9 (and Claims 11, 12, and 15 dependent thereon) patentably distinguish over Nakajima for at least the reasons stated for Claim 1.

Consequently, in light of the above discussion and in view of the present amendment, the present application is believed to be in condition for allowance and an early and favorable action to that effect is respectfully requested.

Respectfully submitted,

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